

REMARKS

Claims 1 and 7-10 are presently pending in the application.

Claim 1 has been amended to incorporate the subject matter from claims 3, 5, and 6, now canceled. No new matter has been added by this amendment, and entry is respectfully requested.

In the Office Action, the Examiner has again rejected claims 1, 3, 5-6, and 9-10 under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,776,634 of Ohkuma et al. (“Ohkuma”) in view of WO 02/48101 of Date et al. (“Date”), relying on U.S. Patent Application Publication No. 2004/0030158 of Date as an English equivalent. Further, the Examiner has again rejected claims 7 and 8 under 35 U.S.C. §103(a) as obvious over Ohkuma et al. in view of Date and further in view of U.S. Patent Application Publication No. 2004/0137368 of Steinmann (“Steinmann”). Applicants respectfully traverse these rejections and the arguments in support thereof for the reasons set forth previously on the record, which Applicants rely upon in full, and for the additional reasons that follow, and respectfully request reconsideration and withdrawal of the rejections.

Rejection Under § 103(a) Based on Ohkuma in view of Date

Regarding claims 1, 3, and 10, the Examiner maintains that Ohkuma teaches a photosensitive recording medium composition containing a radical-polymerizable monomer, a cationic-polymerizable monomer, a radical polymerization initiator and a cationic-polymerization initiator. The cationic initiator may allegedly be represented by formula (I), which the Examiner contends is equivalent to claimed formula (I) when Ar is a phenyl group. The Examiner further argues that specific formula (II) of Ohkuma is equivalent to claimed formula (I) when M is a phosphorus atom. The Examiner acknowledges that Ohkuma does not teach the claimed purity of the cationic polymerization initiator.

However, as previously explained on the record, the Examiner argues that Date teaches a method of manufacturing sulfonium salts used as photocationic polymerization initiators for resists, including the syntheses of (4-phenylthiophenyl)diphenylsulfonium hexafluorophosphate

and (4-phenylthiophenyl)diphenylsulfonium hexafluoroantimonate with a purity of 99%. Date allegedly teaches that these products contained small amounts of starting material, and thus the Examiner concluded that there is no compound represented by claimed formula (II) in the products described by Date. The Examiner takes the position that it would have been obvious for one skilled in the art at the time of the invention to use the sulfonium salts with a purity of 99% obtained in the process of Date as photocationic polymerization initiators in the composition of Ohkuma. Accordingly, the Examiner maintains that the present claims are obvious. Applicants again respectfully traverse this rejection as follows.

The presently claimed actinic radiation-curable resin composition for stereolithography includes a cationic polymerizable organic compound comprising at least one compound having an epoxy group, a radical polymerizable organic compound comprising at least one compound having a (meth)acryl group, a photo initiator for radical polymerization which is sensitive to ultraviolet light, and a photo initiator for cationic polymerization which contains a highly pure (97 weight % or higher) compound represented by formula (I) in which M is an antimony atom and which contains less than 3% by mass of a compound represented by formula (II). The compound having formula (I) is highly pure to improve the aging stability during operation and the storage stability of the composition. Applicants have determined that the stability of the resin composition may be dramatically improved by increasing the ratio of the compound having formula (I) to the compound having formula (II), that is, preferably substantially excluding compounds of formula (II).

In order to demonstrate the superiority of resin compositions for stereolithography as presently claimed in which M in the compound represented by Formula (I) is an antimony atom rather than a phosphorus atom, Applicants have performed additional experiments. Such experiments are set forth in the Declaration of Tsuneo Hagiwara Under 37 C.F.R. § 1.132 (“Hagiwara Declaration”), filed herewith.

As described in the Hagiwara Declaration (paragraph 11), four resin compositions were prepared: two comparative compositions containing a formula (I) compound in which M = P, and two inventive compositions containing a formula (I) compound in which M = Sb. The four compositions were used to form resins which were analyzed to determine the curing sensitivity

and the strength, mechanical, and physical properties of the cured films and test pieces. As shown in Table 1 of the Hagiwara Declaration, the only difference between the “Additional Example 1 and 2” compositions and the “Additional Comparative Example 1 and 2” compositions were the metal in the compound having formula (I).

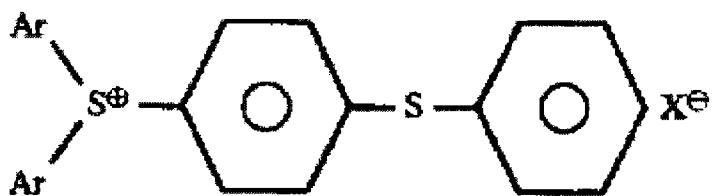
As described in paragraph 12 of the Hagiwara Declaration, the curing sensitivities of the resulting resins were measured by irradiating thin films with different energy levels to produce thin films having different thicknesses. The relationship between the irradiation energy and the thickness cured was obtained by measuring the thickness cured. The results are tabulated in Table 2 and depicted graphically in Fig. B of the Hagiwara Declaration, and are summarized in paragraphs 15 and 16. It was determined that at the same irradiation energy, the films prepared from the photo initiator containing phosphorus (Additional Comparative Examples 1 and 2) were thinner than the films prepared from the photo initiator containing antimony (Additional Examples 1 and 2). The compositions of Additional Comparative Examples 1 and 2 were thus less sensitive than those of Additional Examples 1 and 2; the comparative compositions would require more energy to achieve the same film thickness. Further, it was observed that the cured films prepared from the resin compositions containing the photo initiator in which M was antimony (Examples 1 and 2) were tough and easily handled. In contrast, the cured films prepared by using the photo initiator in which M was phosphorus (Comparative Examples 1 and 2) were weak and easily broken, and thus lacked strength.

In order to evaluate the mechanical strength and visible properties of the films, each composition was used to produce a test piece by stereolithography and then analyzed, as described in paragraph 13 of the Hagiwara Declaration. As shown in Table 3 and summarized in paragraphs 18 and 19 of the Hagiwara Declaration, test pieces prepared from resin compositions containing a photo initiator in which M was phosphorus exhibited remarkably low strength and modulus: because the reactivity of these comparative compositions was low, the curing reaction did not proceed sufficiently. These materials would thus not be practical for use. In addition, since the surface hardness, strength, and interlayer adhesion of these test pieces were low, surface blemishes and peeling of the cured layer were observed during the stereolithography and post-treatment step, resulting in the observed change of shape and poor appearance.

In contrast, the test pieces prepared from resin compositions containing a photo initiator in which M was antimony exhibited good physical properties and dramatically higher strength and modulus properties. Because these compositions have higher reactivity, the curing reaction proceeded to an appropriate extent and practically useful materials were produced.

It is thus concluded in paragraph 20 of the Hagiwara Declaration that when using M=Sb, the curing sensitivity is higher and curing can be conducted with lower irradiation energy than when the photo initiator having M=P is utilized. Further, the latter product had inferior strength, modulus, and other physical properties and was easily damaged, making it very unfavorable from a practical standpoint. It can be seen from the data presented in the Hagiwara Declaration that a dramatic difference in properties was observed when using resin compositions which differed only in the metal element which was contained in the photo initiator for cationic polymerization. These data also clearly show the importance when preparing a resin composition of utilizing a photo initiator containing a compound having formula (I) in which M is an antimony atom.

Ohkuma is directed to a photosensitive recording medium and a method of preparing a hologram using it. Ohkuma discloses a composition containing a radical polymerizable monomer, a cationic polymerizable monomer, a cationic polymerization initiator, and a radical polymerization initiator. Applicants do not dispute the fact that Ohkuma teaches (col. 10, lines 1-25) that a useful cationic initiator may be, among nine other general compositions, a compound having the following structure:



“Ar” represents an aryl group, and “X” may be an anion of BF_4^- , PF_6^- , AsF_6^- , or SbF_6^- . However, this structure encompasses numerous possible compounds and there is no teaching or suggestion in Ohkuma of the superiority of any particular anion over any other, or of any specific aryl group relative to any other. Accordingly, it would not have been expected based on

Ohkuma that utilization of the claimed compound having formula (I) in which M = Sb (corresponding to the Ohkuma compound in which Ar is phenyl and X⁻ is Sb⁻F₆) would be superior to that obtained when M = P, as clearly demonstrated in the Hagiwara Declaration.

With regard to the composition for stereolithography, it would have been generally obvious to one skilled in the art that thermal aging stability tends to decrease when the sensitivity of the composition is increased to improve the reactivity thereof. In the presently claimed invention, both of the above contradictory properties (reactivity and aging stability) can be achieved by using the compound (I) having a high purity, in which M represents an antimony (Sb) atom.

Thus, Applicants have selectively determined the specific photo initiator for cationic polymerization which provides a resin with superior curing selectivity and physical strength. Such results would not have been expected based on Ohkuma, because Ohkuma does not differentiate among any of the numerous possible structures having the formula shown above or among the numerous other compounds depicted in cols. 9 and 10 of Ohkuma. Such unexpected results would thus overcome any *prima facie* case of obviousness which were to be established.

For at least these reasons, reconsideration and withdrawal of the § 103(a) rejection based on the proposed combination of Ohkuma with Date are respectfully requested.

Rejection Under § 103(a) Based on Ohkuma in view of Date and Steinmann

Regarding claims 7 and 8, the Examiner acknowledges that the proposed combination of Ohkuma and Date does not teach that the composition comprises an oxetane compound and a polyalkylene ether compound as claimed. However, Steinmann allegedly teaches a radiation-curable composition useful for the production of three dimensional articles by stereolithography comprising at least one cationically polymerizing organic substance, at least one free-radical polymerizing organic substance, at least one cationic polymerization initiator, at least one free-radical polymerization initiator, at least one hydroxyl-functional compound, and at least one hydroxyl-functional oxetane compound. Accordingly, the Examiner concludes that it would have been obvious to one having ordinary skill in the art at the time of the invention to add at least one hydroxyl-functional compound, such as propylene glycols of various molecular

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weights, glycerine propoxylated polyether triol and polyethyleneglycols, and at least one hydroxyl-functional oxetane compound, as disclosed by Steinmann, to the composition of Ohkuma/Date in order to obtain a composition with exceptionally high photospeed, low viscosity, low humidity sensitivity, and high temperature resistance since such properties are taught by Steinmann. Applicants again respectfully traverse this rejection as follows.

As demonstrated above, it would not have been expected based on the proposed combination of Ohkuma with Date that preparation of a resin composition containing as a photo initiator for cationic polymerization the claimed compound having formula (I) in which M is antimony yields dramatic and superior properties relative to those which are obtained when M is phosphorus. Further, such results would also not have been expected based on the proposed combination of Ohkuma, Date, and Steinmann, since Steinmann does not teach or suggest the claimed compound having formula (I). Accordingly, reconsideration and withdrawal of the §103(a) rejection based on Ohkuma in view of Date and Steinmann are respectfully requested.

In view of the preceding Amendments, Remarks, and Hagiwara Declaration, it is respectfully submitted that the pending claims are patentably distinct from the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,
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Enclosure: Declaration of Tsuneo Hagiwara under 37 C.F.R. § 1.132
Request for Continued Examination (RCE)